Appendix

Alternative non-parametric analysis

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Background

The handling and statistical analysis of clinical data such as those derived from the FIM and NPDS open to debate, and to date there is no generally accepted rule. Some would maintain that all ordinal data should be analysed using non-parametric statistical methods. On the other hand, if the data are subjected to mathematical manipulation (for example dividing FIM gain by length of stay to derive a measure of FIM efficiency) then they are being treated as interval data, in which case parametric analysis would be logical by extension. Many people would argue that this sort of mathematic manipulation is not valid, or is only valid in the middle of the FIM range, where the recovery curve is relatively straight. However, the fact is that in some health cultures, FIM efficiency is widely accepted as a marker of value for money, and rehabilitation services founder or survive on the basis of these figures.

There is now a substantial volume of published literature on FIM efficiency of which a large majority is calculated on the basis of mean total FIM score. In order to be consistent with this literature, we have used the same technique and presented parametric analysis throughout in the published version of this paper. In reality, if the numbers are large, and the data with acceptable limits of normality, then either method should give similar results. We therefore present the alternative non-parametric analysis to confirm that both methods support similar conclusions.

Methods for non-parametric analysis

Data were grouped by category of dependency on admission (see main paper), and summary figures are given for medians and interquartile ranges. Wilcoxon Signed Ranks tests were used to compare differences between paired ratings on admission and discharge within dependency groups. Kruskal-Wallis tests were used to identify overall differences between the three groups. Mann-Whitney tests were used to compare each pair of groups, but to correct for multiple comparisons (two groups for each parameter measured) the p values were multiplied by two, in line with the Bonferroni correction used in our published analysis. The relationship between “reduction in weekly cost of continuing care” and change in NPDS, FIM, and Barthel score was examined using Spearman Rank correlations.

Results

Table 2 shows the age, time since onset, and median NPCNA, FIM, and Barthel scores on admission for each of the three dependency groups.

Table 2 Median (IQR) scores on admission for the different dependency groups.

	Dependency group		
	Low (NPDS <10) (n=83)	**Medium (NPDS 10–24) (n=112)**	**High (NPDS >25) (n=102)**
Age (years)	Median (IQR)	Median (IQR)	Median (IQR)
Time since injury	43 (32–53)	46 (36–56)	45 (32–54)
(months)	2.8 (1.7–4.6)	2.9 (1.7–4.2)	3.9 (2.4–6.8)
Scores on admission			
NPDS score	5 (2–7)	16 (13–20)	36 (30–49)
NPCNA estimates:			
RCH (care hours/week)	14 (10–21)	35 (31–38)	59 (47–66)
Cost of care (£/week)	£168 (144–256)	£856 (410–1100)	£1900 (1332–2216)
FIM motor scale	76 (69–84)	51 (41–62)	28 (16–39)
FIM cognitive scale	29 (25–33)	25 (20–31)	19 (13–24)
FIM total	107 (96–113)	75 (65–88)	48 (31–61)
Barthel index	16 (15–18)	9 (8–11)	5 (2–7)

Note: FIM and BI are scores of "independence" (with higher scores reflecting *less* dependency), whereas the NPDS is a score of "dependency" (with higher scores reflecting *greater* dependency).

Table 3 summarises the median change in scores between admission and discharge for the three dependency groups. In all groups, NPDS, RCH, weekly cost of care, FIM, and Barthel scores all changed significantly from admission to discharge (Wilcoxon signed rank $p<0.001$).

Table 3 Median change in NPDS, NPCNA, FIM, and Barthel scores from admission to discharge and estimates of cost efficiency calculated for the group as a whole.

	Dependency group		
	Low (NPDS <10) (n=83)	**Medium (NPDS 10-24) (n=112)**	**High (NPDS >25) (n=102)**
Instrument	Median change(IQR)	Median change(IQR)	Median change(IQR)
NPDS	−2 (−4 to 0)	−8 (−12 to −3)	−15 (−24 to −10)
NPCNA estimates:			
RCH (care hours per week)	−7 (−14 to 0)	−9 (−23 to −3)	−16 (−26 to −5)
Cost of care (£/week)	−£72 (−132 to 0)	−£153 (−691 to 0)	−£660 (−1156 to −69)
FIM motor scale	8 (4 to 14)	21 (15 to 29)	19 (8 to 31)
FIM cognitive scale	1 (0 to 4)	3 (1 to 6)	4 (1 to 8)

FIM total	111 (4 to 17)	24 (18 to 33)	26 (13 to 38)
Barthel Index	2 (1 to 4)	6 (4.8 to 6.7)	5 (2 to 8)
	Median (IQR)	Median (IQR)	Median (IQR)
Length of stay (days)	64 (46 to 88)	100 (78 to 122)	149(109 to 193)
Median cost of admission	£17,984 (£11,264 to 24,832)	£27,330 (£19,968 to 34,662)	£38,144 (£28,350 to 53,390)
Estimated efficiency based on summary data:			
Time taken to offset the cost of rehabilitation*	62 months	45 months	14.5 months
FIM efficiency†	0.17	0.24	0.17

*Time taken to offset the cost of rehabilitation by savings in cost of care was calculated from "median cost of admission" divided by "median reduction in weekly cost of care" from admission to discharge, as estimated by the NPCNA.
†FIM-efficiency was calculated from the median change in total FIM score from admission to discharge (or "FIM gain") divided by median "length of stay" (days).

Kruskal-Wallis tests demonstrated significant overall differences between the dependency groups for change scores in all the parameters listed in table 4 ($p<0.001$). Group by group Mann Whitney tests demonstrated significant differences in NPDS and 'reduction of cost of weekly continuing care' between all groups. By contrast, the FIM™ and BI detected differences in change between the low and medium dependency groups, but not between the medium and high groups.

Table 4 Mann-Whitney comparing differences in change scores between the three dependency groups

Parameter	**Group comparison**	**Z value**	**p***
NPCNA:			
Cost of care	Medium *v* low	–2.67	0.01
(£/week)	High *v* medium	–3.39	0.002
NPDS	Medium *v* low	–7.37	**<0.001**
	High *v* medium	–5.87	<0.001
FIM total	Medium *v* low	–7.70	**<0.001**
	High *v* medium	–0.57	0.91
FIM motor	Medium *v* low	–7.62	**<0.001**
	High *v* medium	–1.48	0.28
FIM cognitive	Medium *v* low	–2.55	**0.01**

	High *v* medium	–1.75	0.22
Barthel Index	Medium *v* low	–7.14	**<0.001**
	High *v* medium	–1.55	0.240

*Multiplied by two to correct for multiple comparisons.

The high dependency group had significantly longer lengths of stay than the medium (Mann-Whitney z=–5.3, p<0.001) and light (Mann-Whitney z=–8.1, p<0.001) groups. However, calculated on the basis of median changes, the time to offset the cost of rehabilitation by savings in the weekly cost of care was lowest in the high dependency group (14.5 months), compared with 45 months for the medium, and 62 months for the low dependency groups (see table 2). Meanwhile, FIM efficiency remained greatest in the medium dependency group (0.24) compared with 0.17 in the low and high dependency groups.

Table 5 shows the relationship between estimated reduction in weekly cost of continuing care and change in NPDS, RCH, FIM, and BI scores, for the different dependency groups. As with the parametric analysis, the relationship is closest with estimated weekly care hours (RCH) and NPDS, whereas that with the Barthel and FIM is less good, although still significant in the main.

Table 5 Spearman rank correlations between change in NPDS, FIM, and Barthel scores and "reduction in cost of continuing care" in the different dependency groups.

	Dependency group			
	Total (all scores) (n=293)	**Low** (NPDS <10) (n=84)	**Medium** (NPDS 10–24) (n=110)	**High** (NPDS >25) (n=99)
Instrument	Spearman(rho)	Spearman(rho)	Spearman(rho)	Spearman(rho)
NPDS	0.60***	0.46***	0.53***	0.63***
RCH	0.72***	0.89***	0.68***	0.68***
FIM total	0.34***	0.17	0.25**	0.34**
Barthel index	0.40***	0.16	0.49***	0.33**

Significant at p<0.001*** and p<0.01**

Conclusion

Overall, the results of this non-parametric analysis provide similar conclusions to that using parametric statistical methods—namely that the NPDS/NPCNA detected changes in dependency potentially associated with substantial savings in the cost of ongoing care, especially in high dependency patients. Floor effects in responsiveness of the FIM may lead to underestimation of efficiency of rehabilitation in higher dependency patients. This alternative analysis supports the notion that the data essentially speak for themselves, regardless of the analytic technique employed.